EFFICIENT AIRCREW SCHEDULING
IN AN OPERATIONAL
TEST AND EVALUATION ORGANIZATION

THESIS

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Table of Contents

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ABSTRACT

The original intent of this research was to locate or develop tools which would improve the efficiency of the aircrew scheduling process in the 4950th Test Wing. However, late in the research it became apparent that several factors observed by the researcher complicate the implementation of more efficient methods. Therefore, the focus of the research became the documentation of those factors. A case study methodology was used in answering the investigative questions. This was an exploratory study conducted in a field setting environment. Direct observation and the use of structural interviews with scheduling personnel were the methods of data collection. An exhaustive search revealed numerous aircrew scheduling support systems in use within the USAF today. Many others were found under a development and test status. However, it was found that no measure of scheduling efficiency was currently in use in the subject unit. In addition, there was no attempt to use surrogate parameters to measure how well the schedulers were performing their jobs. Recommendations on what parameters may serve as good surrogates for scheduling efficiency are suggested. These parameters may serve as baseline efficiency measures which can serve to assess the success of future improvement efforts.

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I. Introduction

General Issue

The job of aircrew scheduling in an operational USAF flying organization is a very complex and time-consuming task. The planning efforts to construct a single weekly schedule typically begin six days in advance. Schedulers manually match up available flying opportunities to those crewmembers assigned to the unit. This operation takes into account the person's remaining training tasks to be accomplished, the person's availability, and many other scheduling related criteria. When a scheduling conflict goes unnoticed, available opportunities are lost or must be used in a less efficient manner. Examples include scheduling one person in two places simultaneously and attempting to fly an individual whose currency has expired in some required event. The importance of constructing a flying schedule that is free of scheduling conflict has the attention of top level managers. Their concern is with maintaining a proficient, current crew force to ensure mission accomplishment.

The most recent budget cuts have found their way into the flying time resource allocations. With reduced flying

training time to maintain proficiency levels, it becomes even more important to schedule available resources in the most efficient manner. Top level managers will have to answer questions about reduced levels of flying resources. For example, can the flying organization maintain a current and proficient flying crew force with ten percent fewer flying hours?

Specific Problem

Efficient aircrew scheduling in the 4950th Test Wing has not been achieved despite the existence of a number of successful aircrew scheduling support systems. Research is required to explore the circumstances and characteristics which complicate the 4950th Test Wing scheduling environment to facilitate later efforts to improve the scheduling process.

Investigative Questions

The following questions must be answered in order to satisfactorily answer the general research question above.

1. What are the objectives of the scheduling process? If the researcher is to make a recommendation on improving a process, he must do so in light of the relevant objectives.

2. What is the current process? If the researcher is to make a recommendation on improving a process, he must understand and be knowledgeable of the current process.

3. What are the relevant constraints? Constraints can be thought of as barriers to the researcher. He must understand these barriers in order to recognize how they are manifested. If the barriers are understood, the researcher may be able to remove some of them. If not, the researcher must insure that proposed solutions do not violate the constraints.

4. What tools are available to assist in the scheduling process? These include items not currently used by the subject organization but available as a result of previous research into similar scheduling tasks.

5. What tools are currently used to assist in the scheduling process? There may be specific items which are used by the scheduling personnel in the performance of their job and which may facilitate improvements.

6. Why have available tools not been implemented? This question suggests the need to observe first hand the operations within the scheduling office. Barriers to new and different ways of accomplishing tasks need to be identified.

Scope and Limitations

This research is limited in scope to the 4950th Test Wing, 4952nd Test Squadron, Wright Patterson AFB, OH. However, the information gained during this study may be useful to other flying organizations with similar scheduling environments.

II. Review of the Literature

This chapter contains information on the published literature found to date. Sources used to obtain literature included Defense Technical Information Center, interlibrary loan, AFIT, and Wright State University libraries. An attempt to obtain additional material was made by contacting individual flying unit scheduling offices and asking what scheduling tools were used in the field.

Solution Methodologies

There are three commonly used solution methods found in the literature for addressing the aircrew scheduling problem. They are the manual approach, the linear programming approach, and the heuristic approach.

The Manual Approach. The handbook for flight managers, written by Charles A. Craw, provides a useful introduction to the magnitude of data which is considered in the construction of a weekly flying schedule (Craw, 1984). It details many of the requirements and constraints which are common among all aircrew training programs. Also listed are the many volumes of regulations which govern the aircrew scheduling process. Since this report was made in 1984, many of the references have been superseded, but the familiarity offered and guidance given is worthwhile to individuals who are new to the aircrew scheduling problem.

The actual methods described in this report for scheduling aircrews are very laborious and subject to error. The processes are accomplished manually and require inputs from many different sources. At the time this report was written there were other aircrew scheduling aids available which would have assisted the scheduler in all the chores discussed in the report. However, the methods contained in this report are still in use today in the 4950th Test Wing scheduling office. There is a definite gap between what is available and what is presently being used.

Line¬r Programming Approach. Examples of the linear programming approach were found in both the civilian and military establishments. Each of these applications will be discussed, pointing out the pros and cons in each application.

Commercial Airline Applications. One of the most complex, demanding, and expensive computer processes in all the commercial airline industry is used for the scheduling of flight crews (Spitzer, 1987:27-29). The manner in which an airline corporation manages its crewmembers can make the difference between making a profit and losing money. The two primary expenditures a commercial airline incurs are fuel costs and crewmember pay. The crewmembers pay is affected by the amount of temporary duty each crew incurs. The more time the crew is away from their home base, the more it costs the airline company. The commercial aviation

industry has done a lot of work with aircrew scheduling as it pertains to minimizing cost (Gershkoff, 1989:29-43). The years of effort spent by the airline industry have yielded a very profitable linear programming model. The objective of this particular model is to minimize cost by properly matching candidate crews to flights. The savings produced by the linear programming approach relative to the enumeration techniques previously used is estimated at $18 million per year (Gershkoff, 1989:43).

The main focus of the airlines research is to save money. Flight route schedules are built to reduce the amount of time the flight crews are away from home base in order to minimize the extra expenditures for temporary duty pay. This schedule manipulation and objective of minimizing cost for the airline is much different from the objectives of the military scheduler.

Military Applications. The job of the military aircrew scheduler is likewise no simple task. The job of Squadron Scheduler is thought of as one of the most difficult and time-consuming nonflying duties a crewmember can have (Hanley, 1988:25-32).

The complex route structures that an airline faces are much different than a military scheduler faces. With the exception of Military Airlift Command (MAC), the majority of the military flights are round robin. That is, they takeoff

and land at the same base rather than flying a specific route structure.

Carlton L. Pannell demonstrated the feasibility of applying linear programming technology to solve the aircrew scheduling problem. His research focuses on an imaginary A-7D fighter squadron (Pannell, 1980).

The linear program's objective function is one which minimizes the use of flying resources. The constraints of this problem fall into four categories: (1) the number of sorties which can be supported by the available aircraft, (2) the number of each type of sortie which can be supported with other resources, (3) training requirements from applicable guidance, and (4) the training required due to individual pilot proficiency (Pannell, 1980:23).

Although it is clear the use of linear programming techniques to solve the aircrew scheduling problem is feasible, there are disadvantages of using this technique. These disadvantages include the determination of the most desired schedule generated when alternative optima exist and the formulation of the many constraints and decision variables. This approach also lacks the ability to be quickly modified in the field to accommodate changes in scheduling priorities.

The conclusions derived from Pannell's research stated that while the application of linear programming models to aircrew scheduling can improve the efficiency of sortie

allocation, such a system cannot be currently implemented. The primary factors preventing the implementation of the linear programming technique were difficulties in modifying the problem formulation in the field and difficulties in determining the optimum solution. Additionally, the claim of improved efficiency in this research is suspect since no comparisons were done with any other models or techniques.

Heuristic Approach. A heuristic methodology has been employed by units in both Tactical Air Command and Strategic Air Command. Their contributions to solving the scheduling dilemma will follow.

Tactical Air Command. Several Tactical Air Command fighter squadrons have attempted to solve the flight crew scheduling problem (Drowley, 1984). Programs were developed to run on both mainframe and micro computers. Drowley (1984) developed a computer program that assists the unit scheduler in developing the weekly flying schedule for an F-15 fighter squadron. It was written in PASCAL and addressed most of the problems confronted by the scheduler, incorporating both flying and ground training event scheduling (Drowley, 1984:59). The scheduler inputs the weekly flights and ground duties that must be performed. Next the pilot accomplishments and currencies are read in, followed by the individual pilot qualifications. Lastly, the supervisory priorities are inputted. This allows the supervisors to express a preference for certain events over

others. This schedule-producing computer program integrates training accomplishments with scheduling requirements.

The 91st Tactical Reconnaissance Squadron directed their efforts at developing an effective and highly efficient heuristic aircrew scheduling model. Binding requirements and desired objectives formed the basis for the development of their model. It was subsequently implemented in a system of BASIC microcomputer programs (Hanley, 1988:28). The 91st put their heuristic model to practical test by using it to develop the weekly schedule. This schedule was compared to the one produced by the manual method of scheduling. On the average, the number of missions effectively scheduled during the trial week increased by over 10%, and the number of unneeded missions decreased by more than 10%. Both of these improvements were achieved with equal or superior numbers of paired crew members being assigned and with no noticeable difference in the even distribution of flying jobs. In addition to meeting these objectives, the schedule was produced with much less time and effort (Hanley, 1988:32).

Strategic Air Command. Lt Col Steven G. Joseph documented research on automated aircrew scheduling within the Strategic Air Command (SAC) (Joseph, 1986). His efforts were aimed at increasing the effectiveness of aircrew training through more effective scheduling. He concluded that the complexities of the scheduling process and the

enormous number of individual data elements which must be managed and analyzed mandated an automated support system.

He went on to design and develop a scheduling assistance system which ran on the CP/M operating system. This operating system can access only 64K of memory and the program required two disk drives and a printer.

The efforts of Lt Col Joseph's research were directed specifically at the B-52 scheduling requirements in Strategic Air Command. A limitation which reduces its general application is its ability to schedule only entire aircrews, not individual aircrew members. This is an important limitation since the subject organization for this research project does not have "permanent" crews; therefore, each crewmember must be scheduled on an individual basis.

Lt Col Joseph concludes in his report that an automated scheduling system is both necessary and feasible (Joseph, 1986:34-35). The B-52 unit used in his study was shown to have 23,520 data elements. Additional considerations include unit specific requirements, ground training requirements, leave, physicals, higher headquarters missions, DNIF substitutions (crewmembers are restricted to duties not to include flying), staff flying, upgrade training, and numerous other data elements. It is obviously an overwhelming task to manage, examine, analyze and weigh all these data elements. Such a problem makes manual data management infeasible.

Additional support for improvement of the scheduling process is economically related. Lt Col Joseph points out in his report the magnitude of the opportunity cost associated with inefficient scheduling. He sites:

> To achieve a 1 percent improvement (in training rate accomplishment) would require roughly a 1 percent increase in flying hours and sorties. If the same improvement can be achieved through better scheduling, the net result, with B-52 annual flying hour costs in excess of 800 million dollars, is an annual productivity enhancement worth eight million dollars. One study has suggested that a 7 to 10 percent improvement is realistic. To this point, an argument has been made that B-52 units are achieving satisfactory training rates, that improvements can be made, and that the lack of improved scheduling is costly. (Joseph, 1986:6)

The most interesting piece of research found to date is that done by Captain Kopf in his 1987 thesis, "Design of an Aircrew Scheduling Decision Aid for the 6916th Electronic Security Squadron" (Kopf, 1987). Its particular application is limited in scope to one organization, just as this research is limited to the 4950th Test Wing. Its design makes use of the integrated Enable software package available to most scheduling offices. Its purchase price is minimal and would not be considered a major problem should this aid be put into use in the 4950th Test Wing.

Kopf's system is much more than just a scheduling tool. It has the capability of printing flight orders for the aircrew schedule just built, computing 30 and 90 day flight hour computations, and determining recurring training requirements.

Although one of the objectives stated in Kopf's research was the development of more efficient and effective aircrew schedules, there was no evaluation performed on the decision aid. There were several techniques and recommendations given on how this evaluation could be done. Follow-up phone calls to the 6916th Electronic Security Squadron revealed this decision aid to be of no use to the scheduling office. The Unit itself was moved from Hellenikon Air Base, Athens Greece, to Mildenhall Air Base, United Kingdom. Hellenikon Air Base has been closed down for several months. Since the development of this scheduling tool, the actual schedulers in the 6916th ESS have since moved on to other jobs. Successful contact was made with one of the original scheduling office personnel of the 6916th ESS who was stationed at Hellenikon Air Base, when this scheduling aid was developed. In addition the author of this scheduling tool, Captain Kopf, who now is commanding the 6985th ESS at Eilison Air Force Base, Alaska, was also contacted. Both of these individuals felt the major reason this tool was not accepted or used in the 6916th ESS was because of the unit's lack of familiarity with the Enable software package. This lack of knowledge would have affected the user-friendly qualities of the entire scheduling aid.

Research done by Moore and Whitmore was focused in scope to model the aircrew training scheduling process of

the 28th Bombardment Wing, Ellsworth AFB, SD (Moore and Whitmore, 1982). This effort involved the modeling of a B-52 unit scheduling process. It did not encompass the development or writing of a computer program to assist schedulers. Due to the specific elements addressed in this particular model which are relevant only to B-52 unit scheduling, there is little benefit to be gained outside the realm of the B-52 unit scheduling dilemma.

Haylett and Spiess conducted a study on pilot retention in 1980 (Haylett and Spiess, 1980). Although this particular study does not focus on scheduling aids or tools, it still was worthy of mentioning because of its findings. One of the main reasons pilots elected to leave the Air Force is the flying schedule instability. This conclusion was reached after studying the strategic airlift portion of MAC. Regression analysis was performed at a confidence level of 95%. The implication of this result is that scheduling practices or improvements have the possibility to reduce the number of pilots leaving the Air Force. Such an accomplishment would save the taxpayers many training dollars required to replace those departing pilots. It also suggests scheduling is an area to be focused on for improvement, since it is a primary cause of the pilot retention problem.

Lafferty's work ties in with Haylett's and Spiess's research on scheduling stability and pilot retention

(Lafferty, 1976). He suggests unit schedulers use aircrew scheduling as a motivational tool. He believes a favorable motivating force could be introduced much in the same way as flextime or bid system scheduling (Lafferty, 1976: 49). The following benefits are listed from the use of such a tool:

> (1) Higher morale.
> (2) Greater commitment to organizational goals, because of responsibility in planning their accomplishment.
> (3) Schedule stability. A reluctance to interrupt what you've helped create.
> (4) Managerial growth, earlier involvement in the planning process and awareness of requirements.
> (5) Reduction of computer software required to conduct individual schedules.
> (6) Reduce flight examination failures, since individual is responsible for his own training program (Lafferty, 1976:50).

It is important to note that there were no tests made to substantiate any of these stated benefits. In addition, there are some negative impacts of implementing such a tool that will effect the schedule directly. For example, more time will be required to prepare a schedule since many more variables or constraints will be introduced into the process. It will also serve to reduce the scheduler's options. There will be added reasons why an individual would not be able to fly a specific mission.

Summary of Solution Methodologies. Of the solution methods found in the literature for solving the aircrew scheduling problem, the heuristic approach appears to be the most frequently used at this time. The disadvantages found in the linear program method include formulations with so

many variables and constraints that they become impossible to solve within the limits of any practical computational effort. In addition, the dynamic nature of the military scheduling problem requires frequent changes of the parameter values in the linear programming problem. Specific causes of these parameter alterations include unstable availabilities of flying personnel, weather, and maintenance problems. Due to the high degree of interdependency between scheduled flights, the loss of a single planned flight can have a rippling effect throughout the week. These facts prevented linear programming from being a practical solution method in the case of the 91st Tactical Reconnaissance Squadron, and are applicable to the 4950th Test Wing as well (Hanley, 1988:28).

Up to this point the published literature reviewed was mostly done by individuals for a very specific application. Little thought was given to other requirements outside the specific application under study.

Operational Systems

As a result of numerous telephone calls to different scheduling offices, this researcher gained information about many additional computer assisted scheduling tools in use at the present time in the USAF. Perhaps the most important contact was with the chief of Operations Support at the 1912TH Computer System Group (TAC) (Hess, 1991). It was discovered through this office that a Scheduling Working

Group has recently been established for the purpose of consolidating the requirements of schedulers throughout the Air Force. At the time of this telephone interview, the group had already met twice.

Adding up all the different efforts known to exist today, one finds fifteen separate programs in use. All these programs are scheduling tools, eight of which are already fielded, with the remainder at different stages of development. Of these fifteen programs, nine were developed for TAC. The following paragraphs provide a brief narrative of each of these scheduling tools, stating their purpose, giving their present status, and listing the specific users of the system.

Combat Airspace Deconfliction System - CADS. This system allows for airspace data entry, while automatically checking for conflict. It also allows for the manipulation of airspace for deconfliction or replanning. This air picture is stored for future use. An Airspace Control Order (ACO) is also produced by the system.

Users of this system include the 9AF, 12AF, 21AF, HQAFSOC, Airlift Control Center (ALCC), Army Battlefield Coordination Element (BCE), and Army battalion level. The system is fielded and the software is at the end of its lifecycle, in need of a redesign and rewrite.

Airspace Deconfliction System - ADS. This system has the same capabilities as CADS. It is a prototype system

currently in development. Users are the 9AF and 12 AF Tactical Battle Planners.

Military Airspace Intrusion Detection System - MAIDS. This system also has the same capabilities as CADS. In addition, it provides information and graphics for flight information publication and FAA orders. Users include special use airspace managers, 1AF, 11AF, Air Defense Sectors, and FAA Headquarters. The system is presently fielded but is in need of redesign.

Aircrew Airspace Scheduling System - ACASS. This is an automated wing and squadron scheduling system used for aircrew, airspace, and mission scheduling. It was designed primarily to relieve the burden on the pilot scheduler. This system is currently fielded but design has begun for a replacement system. Users of this system number well over 100 wing and squadron scheduling units.

Air Defense Sector Airspace Management System - AAMS. This system provides for air defense sector airspace management, scheduling missions and mission packages, deconfliction, and report generation. The users of this system are the Air Defense Sector Wings and Squadrons. The prototype AAMS was evaluated in December 1990. As a result, twenty software change proposals were submitted. Development of these changes has not yet been scheduled.

FAKER. This is not an acronym but the name of an electronic countermeasures flight training scheduling

system. It's purpose is to provide the FAKER PMO with real time capabilities for scheduling, verifying services, and tracking expenses for the contracted ECM and NON-ECM training flights. This system is currently fielded and a new release is due to be issued in July 1991. Users include the FAKER PMO, flying units of the Air National Guard, Tactical Air Command, and PACAF.

Defense Electronic Jamming Authorization System - DEJAS. The purpose of this system is to allow pilots near real time approval to fly ECM missions. Current design incorporates a semi-automated ECM clearance notification and request for authorization with the FAA. The system will deconflict the airspace or the ECM mission with the airspace of the FAA radars. The current approval system takes weeks before an authorization is received.

This system is not yet fielded. System requirements are still being finalized. The airspace deconflicting requirements in this system are similar to those in CADS. The primary user will be FAKER PMOs and the FAA.

Low Level Deconfliction - LLD. The purpose of this system is to schedule and deconflict low level point to point training missions. These missions are normally flown in special use airspace or a military operating area. The primary user is TAC. The system is currently fielded and is undergoing design upgrade modifications.

Wing Command and Control System - WCCS. This system is designed for wing commanders and staff to effectively command control, and manage forces in support of combat sortie generation and reporting. The unit schedulers receive air taskings and airspace coordination information from force level systems and automatically apply wing assets to deconflict takeoff, refueling, and mission objective times. For peacetime operation, the system should provide a means to build, change, coordinate, and generate hard copy forms for daily, weekly, quarterly, and annual flight schedules.

Users of this system include wing level battle staffs, and wing and unit schedulers. The system is currently under development using a rapid prototyping design scheme.

Military Airspace Management System - MAMS. The purpose of MAMS is airspace scheduling. Users include SAC, MAC, ATC, TAC, ANG, Navy, and the FAA. This system has been in operation for three years and is currently being rewritten in the ADA language. The completion estimate for this new effort is FY [illegible].

Scheduling Assisted System - SAS. SAS is an automated flight scheduling tool designed for SAC. It automates the unit's monthly operations plans and builds three month crew flow schedules based on scheduling concepts and wing parameters. The system considers leave schedules, alert cycles, combat crew rest and recuperation time (CCRR),

TDY's, stand down days, and ground training events. The system then flows each day's flight in accordance with the operations-maintenance sortie contract for the quarter. Flights are equally scheduled for training and currency in accordance with SAC regulations and AFORMS.

This system is currently in a test status. Mission adequacy and utility will be determined from these test results. The users in SAC include 14 bomber units and 22 tanker units.

SAC Aircrew Scheduling Aid - SASA. SASA is another aircrew scheduling aid under development for SAC. The purpose of this system is to ease the workload on the schedulers while ensuring a quality product. This project is currently in transition from a demonstration prototype to a functional prototype status. Operational field testing was to begin in July 1991.

Alaskan Scheduling System - ALCOM. This system is in the prototype development stage. It will require a SUN workstation to operate and uses the UNIX operating system. The program is written in the C programming language.

This system is designed to automatically schedule and deconflict. Airspace is deconflicted by time. Missions are deconflicted by both takeoff and landing time, and airspace entry and exit times. Aircrew deconflicting considerations include scheduled missions, crew rest, and non-flying activities. Aircrews are scheduled by currencies,

qualifications, availability, and duty position. Only a single type of aircraft is accommodated by this system. Outputs from the system will include the flying schedule, aircraft usage, and daily missions flown.

AFRES Deployable Operation Training System - ADOTS. The purpose of this system is to track training requirements and currencies for flying units, weapons, and ground training. It is meant to be a deployable system. This system is still in the development stage. Scheduling modules are currently being developed that will update schedules for flying personnel to meet training requirements. Future plans will include weapons considerations. Users of this system include AFRES, ANG, TAC, SAC, and MAC.

Military Airspace Management System - MAMS. MAMS is another prototype system under development for SAC. It is being designed to run on a 386 personal computer or a SUN work station. The program will use an ORACLE database and is written in C. Some of its capabilities include scheduling airspace, such as military operating areas (MOA) and special use airspace (SUA), for single types of aircraft, and scheduling missions for multiple types of aircraft. It will deconflict airspace by entry and exit times and by altitude. The only output product will be an airspace usage report.

It is obvious from the brief descriptions given in the previous paragraphs that much effort and substantial resources are being expended in the area of aircrew scheduling. Unfortunately there is also a lot of duplication of effort taking place within the Air Force on this topic. It was my intention not to add to this duplication of effort. The original intent of the research was to locate or develop tools which would make the subject unit's scheduling process more efficient. However, during the later stages of exploring alternative methods with the test wing schedulers, it became apparent that other factors were significantly affecting the scheduling process. Although no literature review had been accomplished with respect to these factors, it was determined that their documentation in the form of a case study would provide a valuable contribution. Therefore, the balance of this research will focus on the characteristics of the subject organization which bear on the ultimate success of potential scheduling solutions.

III. Methodology

Design Classification

Although beginning as an attempt to find efficient scheduling methods, the research evolved to focus on the complicating characteristics of the 4950th Test Wing scheduling environment. Therefore, the research ultimately utilized a case study design methodology. It was an exploratory study conducted in a field setting environment. Direct observation and structured interviews were the methods of data collection. The first investigative question asks "What are the objectives of the scheduling process?" This was answered primarily by conducting structured interviews with key personnel in the 4950th Test Wing scheduling department. Appendix B to this research contains the interview questionnaire. In addition, a review of appropriate regulations and operating instructions concerning the scheduling process has been done. A list of these regulations and the most current publication date is contained in Appendix C. The second investigative question asks "What is the current process?" This was answered by interviewing current scheduling personnel, by reviewing applicable regulations and operating instructions, and by direct observation. Actual scheduling meetings were attended to observe the process in action first hand. The scheduler's descriptions of the process were compared to the

actual observations. This helped to eliminate the bias conveyed by schedulers describing how they think a process is working rather than how the process is actually run.

The third investigative question asks "What are the relevant constraints?" This was answered by interviews and the research of applicable regulations and operating instructions.

Investigative question four asked what tools were available to assist in the scheduling process. A variety of sources were used to determine the existence of other available tools. These sources include the literature, training authorities, other flying units, MAJCOMS, and commercial industry.

Investigative question five asked what tools were used to assist in the scheduling process. Interviews with scheduling personnel gave us the answer to this question. Direct observation also revealed specific tools used in the process.

Originally, the final investigative question dealt with the determination of the best tool to satisfy the subject units needs. However, initial attempts to explore alternative methods were frustrated by complications within the scheduling environment. Therefore, a combination of interviews and direct observation were utilized to ascertain why available (or potentially available) tools continue to go unused. In addition, observations were made concerning

the use of scheduling tools made available to the scheduling office during the course of this study.

IV. Findings

Office Organization

The scheduling office in the 4952nd Test Squadron was manned by three officer and three enlisted personnel. The chief scheduler position was filled by a senior pilot who also acted as the assistant operations officer. The other two officers were a pilot scheduler and a navigator scheduler. The duplication of the pilot schedulers was necessary to man the office when one or the other is gone. Quite frequently one of these two individuals will be TDY, flying, or on leave status. This does not permit much overlap within the scheduling office. The navigator scheduler is tasked with scheduling the squadron navigators. The enlisted office personnel include one flight engineer scheduler, responsible for scheduling the squadron's flight engineers, and two administration specialists, who are responsible for updating the Air Force Operations Management Systems (AFORMS) and take care of other office duties.

Objectives

Investigative question number one asks, "What are the objectives of the scheduling process?" Results from interviews with the chief scheduler and the pilot scheduler suggested the following objectives for the scheduling process are to 1) accomplish the mission, 2) complete squadron training activities, and 3) maintain proficient

crewmembers. The order of these objectives is significant in that if a conflict occurs, the higher priority objective will be fulfilled. A review of the scheduling operating instructions stated that "our goal is to keep crewmembers current, trained, proficient, and ready to perform worldwide flight test missions". There was no measure currently employed within the scheduling office to record how well they were achieving this goal.

Many of the operational missions flown by the 4952nd Test Squadron receive the highest of DOD priorities. This results in much attention and a high desire to accomplish each and every mission to 100% capacity. Thus, the manning of these operational missions receive the highest priority.

The training of new crewmembers is a task which the 4952nd Test Squadron must accomplish within their unit because of their unique mission requirements. The completion of this training, which provides a fully mission capable crew force, was the second priority of the scheduling office. This training was divided into three phases. Phase one was the basic aircrew qualification and was normally completed in less than three months. Phase two was training which familiarizes the pilots with all the different models of aircraft which the unit flies. The last phase was devoted to the main mission of the unit and can take up to six months to complete. The completion time was dependent on the

operational missions flown during the training period since an actual mission must be flown to complete this training.

The last priority of the scheduling office was aircrew currency. In order for a crewmember to remain fully mission capable their currencies must not expire in any of the numerous flying and ground training events. This category was also known as continuation training.

The Process

Investigative question number two asks "What is the current process?" An operating instruction listed specific activities to be accomplished each day of the week. This specific sequence of events will now be covered.

On Monday the status of all crewmembers was checked. Specific requirements for the following week were determined by reviewing individual currencies and sortie requirements. Flight evaluations due for the next three months were determined. Training requirements received from DOT were reviewed. Mission Evaluations remaining were also checked, but it's unknown for what time period. A phone call was made to those crewmembers who were non-current or close to being non-current and a schedule adjustment made to get their currencies back or updated. Last, all AFORMS products were annotated to identify priority scheduling.

On Tuesday the squadron scheduling office received the SOFT (working plan) schedule from DOMS (Deputy Commander for Operations Mission Scheduling). This SOFT schedule was the

working plan for the next week's schedule that reflects the expected maintenance support and aircraft availability. The Wing Commander (CC) and Deputy Commander for Operations (DO) secretaries were contacted next to schedule the CC and DO to fly. Takeoff times and sortie durations were changed to accommodate their needs. Next, squadron personnel were assigned to the remaining flights on the DOMS SOFT schedule.

On Wednesday the completed SOFT schedule was returned to DOMS. The Wing Staff scheduling meeting also takes place on this day. At this meeting the DO was briefed on the status of crewmembers in training, checkrides, and ground training requirements.

On Thursday the wing scheduling personnel met with the maintenance personnel and assigned aircraft tail numbers, takeoff, and landing times to the SOFT schedule. The squadron schedulers also notified DOMS of any changes made to the schedule since Wednesday. The changes were considered SOFT changes and were incorporated into the weekly HARD schedule. This distinction between SOFT and HARD schedules was primarily used by the maintenance departments to track changes and deviations from the HARD schedule. The operations branch did not track these deviations from the SOFT or HARD schedules.

On Friday, the HARD schedule was received from DOMS. This schedule was compared to the requested schedule submitted earlier. Any changes required were annotated in

red. Those crewmembers affected by short-notice changes were contacted by the scheduling office.

It was stated in the schedulers' operating instruction that the primary responsibility of the flight schedulers was to assure mission requirements are met. All currency and training requirements were to be accomplished in a timely manner. Another goal states that no changes were to be made to the scheduling board once it was posted. Unfortunately this was one goal that the schedulers consistently fail to accomplish.

Additional Duties

What has been covered thus far are the events which take place in order to build the next week's flying schedule. There were additional tasks which must be performed by the schedulers. These may not contribute directly to the actual scheduling building process, but were part of the scheduling officer's responsibility. Flight orders for the next day's flying activities were prepared and checked for accuracy. Changes to the weekly schedule board were made and annotated in red. Crewmembers that were affected by these changes were notified by telephone, electronic mail over the wing information system (WIS), or in person. The monthly schedule board was also updated with the individual crewmember changes and TDY assignments for that month.

Job Overload. It has been observed that the chief scheduling position is certainly a full time job. The job involves a wide variety of responsibilities and demands for time. Currently the scheduler also fills the role of assistant operations officer. In addition to this, he has the responsibility for the squadron Total Quality efforts, to include tracking and submitting frequent reports concerning the unit's Total Quality efforts. Finally, the scheduler is also given some programmatic responsibilities. The organization is a test and evaluation unit and all members share in these program responsibilities.

Constraints

Investigative question number three asks, "What are the constraints?" There were three constraints given by the chief squadron scheduler. The first was that of maintenance work hours. They were set between 0730 and 1630 each day. Flying schedules which go outside these normal maintenance work times require overtime work and special coordination with maintenance. The second constraint was aircraft that fly more than once in a day must have three hours scheduled between sorties. This down time allowed for proper maintenance actions and servicing to take place before the second sortie takeoff time. The last constraint was self imposed by the unit and restricts the crewmembers workday to 12 hours rather than the standard Air Force limit of 16

hours when flying activity include practice instrument approaches or touch and go landings.

It is reasonable to generically categorize constraints as either uncontrollable or controllable. These two categories will be discussed in the following section. The three specific constraints mentioned by the 4950th Test Wing personnel will be discussed within the context of the two generic categories.

Uncontrollable Constraints. No matter how much time and effort the scheduler devoted to the development of the weekly schedule, changes had to be made to this plan. These changes were inevitable due to the large number of uncontrollable events which the scheduler must contend with. The following are examples of these uncontrollable events:

Weather - Visibility or ceilings can go below the minimum required for safe peacetime operations or can severely restrict those events which can be performed on a flight. Crosswinds can also restrict takeoff, landings, or touch and go activities.

DNIF - Sudden illness or injury of a crewmember may force the cancellation of a mission or cause an alternate crewmember to fill the vacancy.

Aircraft Malfunctions - Numerous subsystems must be operating normally in order to conduct safe flying activities. Failure of any critical subsystem that cannot be quickly repaired will cancel the flight.

Short notice Higher Headquarters operational mission requirements - These include mission slips, which are extensions to the planned mission scenario due normally to test vehicle repairs or adverse weather.

Family Emergencies - Immediate and extended family emergencies must be taken care of and sometimes impact the planned schedule of a crewmember.

The second constraint that the scheduler must contend with is that of maintenance time needed to service the aircraft between scheduled flights. This is an uncontrollable constraint because there is nothing the scheduler can do to shorten this time interval when multiple flights are scheduled on the same aircraft.

Controllable Constraints. There were also many events impacting the schedule which fall into the controllable category. The scheduler can take charge of these events and build his weekly schedule with these in mind. There should not be schedule conflicts with respect to these controllable events. Some examples of controllable events include:

Meetings.

Ground training - Physical exams, instrument school, survival training, written exams, and simulator training.

Appointments.

Under the current scheduling process there was little if any control exercised over any of these events. This resulted in numerous scheduling impacts (changes) to the

weekly schedule. These changes typically had a rippling effect throughout the remainder of the weekly schedule. When the changes to the weekly schedule due to uncontrollable events are added to the changes due to the controllable ones, the result was a very unstable and unpredictable schedule. Although the actual number of changes to the weekly schedules was not tracked, over the course of this study it was typical to observe changes to over fifty percent of the planned activities for the week. Since the tracking of these changes or deviations was not performed in the squadron, reliance on the schedulers' self-reporting was necessary for this data. They confirmed that fifty percent was a conservative figure and it frequently exceeds this amount. If these controllable event changes could be eliminated from the weekly schedule it would go a long way toward adding stability to the schedule.

The first and third constraints which the scheduler must contend with were that of restricted maintenance work hours and crew member work day limitations. Both of these fall under the controllable category since changes within the organization can remove these restrictions. Additional funds allocated for maintenance can expand the regular hours currently imposed on the 4950th Test Wing. Also, local policy changes can expand the length of the crew members' working day to 16 hours even when practice instrument approaches or touch and go landings are performed.

Available Tools

Investigative question number four asks, "What tools are available to assist in the scheduling process?" The discussion in chapter two revealed many tools potentially available to assist schedulers in the performance of their duties. Many of these were found to be in use in other organizations today, while others were never implemented. Proliferation of software tools has been the dominant trend in the development of scheduling aids. Many operational flying units have developed in-house scheduling software with their own technical expertise. Most of this effort is for individual applications so that the particular unit remains the sole user of this developed scheduling software aid.

In addition to the numerous scheduling aids previously described, two spreadsheets were written by the author to assist the 4950th Test Wing schedulers with the building and tracking of the weekly and monthly schedules.

Tools Currently In Use

Investigative question number five asks, "What tools are used to assist in the scheduling process?" The scheduling office keeps track of the pilots' weekly and monthly schedules on three large grease boards. One board contains the monthly schedule and two boards the weekly schedule (one for the present week and the other for the following week). These boards cover two complete walls in the schedulers'

office. Changes are made daily to these boards. The schedulers use three different AFORMS products to assist in the building of the weekly schedules. A training report is also sent to the scheduling office from the training office which informs the schedulers of new crewmembers' training requirements. A deployment forecast is received from DOMM which contains the mission support requirements for the month. Finally, an individual forecast log is maintained which crew members use to inform the schedulers of their non-flying activities in order to keep their schedules conflict free.

Barriers to Change

The last investigative question asks "Why have available tools not been implemented?" There are many factors which could lead to the nonuse of the available tools. These factors will now be described.

Education and Training. Interviews with the current scheduling personnel found a definite lack of knowledge concerning what scheduling tools exist, either in the commercial or military establishments. Awareness of different scheduling tool resources is necessary in order to make efficient use of these systems. This lack of awareness of the scheduling systems available today may be attributed to the complete lack of any training given to the schedulers before they were assigned to this position. This tends to force each new scheduler to "reinvent the wheel".

Unfamiliarity with Scheduling Tools. Since there is no formal training given to the schedulers, the familiarity with different scheduling tools must be obtained through on-the-job training. This has not proven to be very effective in this case study. On two separate occasions new scheduling tools were introduced to the scheduling office to see if they would be used. Neither effort ever went beyond the demonstration phase. This adds support to the theory that any scheduling tool to be used in the scheduling office must have a through training program combined with it.

Resistance to Change. Resistance to change is a tremendous force to overcome. According to Daft and Steers there are five sources of resistance to change. These are self interest, uncertainty, lack of understanding and trust, different perceptions and goals, and social disruption (Daft and Steers, 1986:575-580). The observations gathered in this case study reveal many of these sources of resistance to change. We would expect these to be a formidable barrier to overcome in order to institute improvements in the scheduling office.

Definition of an Efficient Schedule. It was observed that no performance measurement parameters exist in the 4950th Test Wing scheduling office. Nowhere in the scheduling operating instructions or within the scheduling office are criteria established for what constitutes an efficient schedule. There is a goal of keeping crew members

current, trained, proficient, and ready to perform worldwide flight test missions, but no real guidance or measures on how to best obtain this goal.

Personnel Stability. Since this study began two of the three officers assigned to the scheduling office were assigned to new positions in the unit. Neither of these individuals were in the job long enough to learn it thoroughly much less help to improve it. The chief scheduler has been in the position for almost a year and has maintained some stability in the manning of the office. This personnel changeover is common in many military organizations and is certainly not unique to this unit.

V. Conclusions and Recommendations

Scheduling Priorities

There is conflict among the scheduling priorities as they are currently set up. Annual checkrides and mission checks are completed after new training is done. This could result in a fully trained crewmember going noncurrent (checkride expires) and becoming non-mission-capable. Should such an individual be needed for an operational mission, the scheduler would not be able to use him. If this individual was the only one who could support such a mission, it could prevent mission accomplishment.

The Process

As described in Chapter Four, the time involved in the development of the flying schedule is substantial. The scheduler expends a tremendous amount of effort in trying to put together what he believes to be an efficient schedule. Unfortunately, the goal of no changes once the schedule is posted on the board is never achieved. In fact, the number of changes made to the weekly flying schedule often exceeds the number of planned events that actually took place. basic problem in trying to develop an efficient flying schedule is the lack of a definition for efficiency. The term efficiency is used in the scheduling operating .mt instruction but no definition of an efficient schedule is made. Personnel within the scheduling office could not

define what an efficient schedule was or what goes into developing an efficient schedule. Also, there were no measures of scheduling efficiency in existence. Thus, no comparisons from one weekly schedule to the next could be made.

Job Focus

As observed first hand and described in Chapter Four under "Additional Duties", there is little effort in the scheduling office to focus on their primary responsibilities. They are given additional tasks to perform which reduce the amount of time available to accomplish their scheduling goals. These extra taskings detract from the office capabilities and prevent an efficient scheduling product.

Constraints

The current scheduling process exercises little if any control over the constraints discussed in Chapter Four. This results in numerous scheduling changes to the weekly schedule. These changes typically have a rippling effect throughout the remainder of the week. When the changes to the weekly schedule due to uncontrollable events are added to the changes due to the controllable ones, the result is a very unstable and unpredictable schedule. Although the actual number of changes to the weekly schedules was not tracked, over the course of this study it was typical to

observe changes made to over fifty percent of the planned activities for the week. Since the tracking of these changes or deviations was not performed in the squadron, reliance on the schedulers' self-reporting was necessary for this data. They confirmed that fifty percent was a conservative figure and it frequently exceeds this amount. If these controllable event changes could be eliminated from the weekly schedule it would go a long way toward adding stability to the schedule.

Available Tools

Many scheduling tools are available today. However, no tool can help an organization if it is not put to use. These tools will not be put to use unless there appears to be a need for them. This need will not arise until some measure of efficiency is agreed upon and used in the scheduling office. In this way, recommendations on how to increase efficiency by applying certain scheduling tools can take place. Prior to that time, the application of such scheduling tools is unlikely, and may even degrade the current process if incorrectly applied.

Tools Currently Used

The manual approach to developing the weekly schedules is still being used by the 4950th Test Wing scheduling office. This method is very laborious and does little to ease the workload of the office personnel. In addition,

this method is prone to errors because of the numerous data elements that must be tracked and evaluated from several different sources.

Personnel Stability

Personnel assigned to the scheduling office do not remain in that position long enough. This frequent turnover of personnel prevents the formation of any corporate knowledge. This fluid movement of personnel deters efficient operations within the scheduling office.

Recommendations

Modifying Scheduling Priorities. Prioritize the objectives in order not to put mission accomplishment at risk and violate the first objective of the scheduling office. This is simply a matter of re-ordering the second and third objectives. The new sequence would be 1) accomplish the mission, 2) maintain proficient crewmembers, and 3) complete squadron training activities.

Job Focus. All the different duties and responsibilities required of the chief scheduling officer detract from his main responsibility of managing the squadron flying resources. Since the job of aircrew scheduling is already a full time job in itself, it is recommended the additional duties and programmatic responsibilities be directed elsewhere. In this way the

squadron scheduler can focus on his primary responsibility and perform the job to the best of his ability.

Reducing Constraints. If the controllable constraints could be reduced or eliminated, stability would be added to the weekly schedule. Local policies should be enacted and enforced to reduce the large numbers of constraints which cause changes to the weekly schedule. This implies that some freedom or flexibility currently given to the individual crew members will be lost. However, this may be preferred to the current chaos. One must remember that although changes made to the schedule may benefit one crew member, they may impose hardships upon another crew member. Personnel often think only of the convenience they receive when imposing schedule changes rather than the inconvenience they are imposing on someone else.

Efficiency Defined and Measured. Before we can talk about what measures we might want to use as a surrogate to indicate how efficient the 4950th scheduling operation is, we must define what makes up an efficient schedule.

The time one devotes to performing a certain task might suffice for some measures of efficiency, but in this case a more appropriate measure would be the number of changes that must be made to the weekly schedule. This parameter offers more than simply time expended since if a quick schedule was put together just to reduce the time involved, it would have numerous changes made to it before the weeks activities were

completed. Thus the overall time spent in schedule development and subsequent changes to it would be greater than if more time was spent on its initial development. Also, if careful thought went into the development of the weekly flying schedule, there would be very few changes made to it throughout the week. Ideally only those changes due to the uncontrollable circumstances mentioned earlier would have to be made. Therefore, the number of changes can be a measure with which to judge the office scheduling efficiency. Fewer changes made to the weekly flying schedule reflect a more efficient schedule. If desired, the controllable items could be tracked separately from the uncontrollable ones.

Another possible measure for scheduling efficiency is the number or percentage of pilots that have completed all their semi-annual requirements per unit time. Currently no emphasis is placed on accomplishing the pilots' semi-annual requirements until the fourth or fifth month of the requirement window. This is the point in time at which everyone tries to get flights scheduled so they can complete all their required activities. This creates a dilemma for the scheduler. Uncontrollable events could prevent some crewmembers from obtaining their required training. If this should happen, a crewmember could be put on non mission capable status or a less than fully qualified status. A more logical approach would be to track the semi-annual

training requirements throughout the entire six month training period and schedule crewmembers with respect to the amount of requirements remaining. If this technique were used throughout the training period, no individual would be lacking in a large number of events at the end of the training cycle. Schedule flow would become more consistent throughout the training period.

Tools Available. It is highly recommended that the grease boards be done away with in the scheduling office. This is an archaic way of keeping track of the squadron schedule and is in need of improvement. In order to bring this task into the 20th century a spreadsheet was introduced into the scheduling office. Since the schedulers had no computer hardware to use, a laptop was procured for the scheduling office. Spreadsheets for both the weekly and monthly schedules were built. This has the advantage of saving all the original schedules and making the daily changes to the weekly and monthly files. At the end of the week the original schedules can be compared to the final schedule and changes or schedule deviations can be tracked very easily within the spreadsheet. By using a spreadsheet, the scheduler no longer has to climb up on chairs to make schedule changes high upon the walls. It can all be done at his desk with a few keystrokes. If a hardcopy is needed a printer is available nearby for their use. Another benefit of the spreadsheet is that it can be printed out to a text

file. This text file of both the weekly and monthly schedules should be updated daily and uploaded on the units main frame computer, called the Wing Information System (WIS). Each crewmember has an account on the WIS and should check it for messages and schedule changes on a daily basis. This will enhance communications between the scheduling office and all crew members. This electronic mail communications has great potential to enhance the communications both to and from the scheduling office if it is put to proper use.

Personnel Stability. Civilian personnel are often used where stability in work personnel is desired. This is one option that could be exercised in the scheduling office, making a civilian the assistant or chief scheduler for the unit. If military personnel are to man all the scheduling office positions, a more stabilized time period could be established for a person to be required to stay in a scheduling position.

Recommendations for Further Research

Once an efficient schedule has been defined, the scheduling tools discussed earlier in this report can be tried and evaluated. A baseline efficiency rating should be established before any new tools or methods are introduced to the scheduling process. Once this baseline is established, those tools that appear helpful in making the schedulers' job easier and more efficient should be tried.

Efficiencies need to be remeasured following the application of each new tool used. In this way comparisons can be made with the baseline and among various tools implemented.

Periodic contact with the 1912th Computer System Group should be made. Schedulers can give inputs for future system requirements currently under development and also keep informed on the latest developments in scheduling tools. Time permitting, attending the scheduling working group meetings may be worthwhile.

Appendix A: Glossary of Acronyms

AAMS --- Air Defense Sector Airspace Management System.

ACASS -- Aircrew Airspace Scheduling System.

ACO ---- Airspace Control Order.

ADS ---- Airspace Deconfliction system.

ADOTS -- AFRES Deployable Operation Training System.

ADS ---- Airspace Deconfliction System.

AF ----- Air Force.

AFB ---- Air Force Base.

AFR ---- Air Force Reserves.

AFIT --- Air Force Institute of Technology.

AFORMS - Air Force Operations Management Systems.

AFRES -- Air Force Reserves.

ALCC --- Airlift Control Center.

ALCOM -- Alaskan Scheduling System.

ANG ---- Air National Guard.

ATC ---- Air Training Command.

AU ----- Air University.

BCE ---- Battlefield Coordination Element.

CADS --- Combat Airspace Deconfliction System.

CCRR --- Combat Crew Rest and Recuperation

CP/M --- Control Program for Microcomputers.

DEJAS -- Defense Electronic Jamming Authorization System.

DNIF --- Duties Not to Include Flying.

DO ----- Deputy Commander for Operations

DOMM --- DO's Mission Planning Organization.

DOMS --- DO's Wing Scheduling Office.

DOT ----- DO's Training Organization.

ECM ----- Electronic Countermeasures.

ESS ----- Electronic Security Squadron.

FAA ----- Federal Aviation Administration.

FY ------ Fiscal Year.

GSM ----- Graduate Systems Management.

GST ----- Graduate Strategic and Tactical Sciences.

IAW ----- In Accordance With.

ICAM ---- Integrated Computer Aided Manufacturing.

IDEF ---- Integrated Computer Aided Manufacturing Definition.

LLD ----- Low Level Deconfliction.

LSR ----- *Department of Communications and Organizational Sciences.*

MAC ----- Military Airlift Command.

MAJCOMS - Major Commands.

MAMS ---- Military Airspace Management System.

MAIDS --- Military Airspace Intrusion Detection System.

MOA ----- Military Operations Area.

PACAF --- Pacific Air Forces.

SAC ----- Strategic Air Command.

SAS ----- Scheduling Assisted System.

SASA ---- SAC Aircrew Scheduling Aid.

SUA ----- Special Use Airspace.

TAC ----- Tactical Air Command

TDY ----- Temporary Duty.

USAF -----United States Air Force.

WCCS ---- Wing Command and Control System.

WIS ----- Wing Information System.

APPENDIX B: Interview Questionnaire

1. Name:

2. Position/Responsibility:

3. What are the objectives of the scheduling process? Rank multiple objectives in order of priority.

4. Are there any formal written scheduling objectives?

5. Do you have any guidance from regulations or operating instructions concerning objectives? If so, what are they?

6. What is the current process used in developing the schedule?

7. Is there any regulation or operating instruction guidance used during the development of the schedule?

8. What are the relevant constraints? Where applicable give reference to where the constraint comes from.

9. Have you had any affect on or made any changes to these constraints?

10. Do you have any tools to assist in the development of the schedule?

11. Do you know of any tools which are available for the scheduling function?

Appendix C: Regulations

AS OF: 23 Aug 91

BASIC/DATE	LAST CHG/DATE	SUP/DATE
1C-18A-1-1/01 APR 84	2/01 DEC 86	
1C-18A-5/01 JUN 87		5S-2/28 JUN 90
1C-18(E)B-1/01 DEC 85	3/17 SEP 91	TW PROCED 91-1 1S-4/07 MAR 91
1C-18(E)B-1-1/15 SEP 86	1/17 SEP 90	
1C-18(E)B-5/01 OCT 86	2/17 SEP 90	
1T-37B-1/01 APR 91		
1T-39A-1/23 JAN 84	5/03 JUL 89	
1C-135-1-1-1/01 SEP 84	4/01 SEP 86	1S-3/24 JAN 87 1S-4/10 AUG 87 ALCMSG/15 SEP 87 1S-6/20 FEB 88 1S-7/15 JAN 89 1S-8/03 MAY 90
1C-135A-1/15 NOV 64	81/30 OCT 90	1S-86/17 AUG 89 1S-93/06 NOV 90
1C-135(E)N-1/30 OCT 78	26/15 JAN 91	1S-34/06 NOV 90
1C-135(K)A-1/16 FEB 66	73/01 DEC 90	1S-149/17 AUG 90 1S-155/06 NOV 90 1S-157/05 MAR 91
1C-135(K)A-1-1/15 JUN 66	64/01 APR 90	
1C-135(K)E-1/15 OCT 82	24/01 FEB 91	1S-22/17 AUG 89 1S-28/06 NOV 90
1C-135(K)E-1-1/15 OCT 82	17/01 MAR 90	
1C-135-101/31 DEC 91		
1C-141A-1/01 AUG 87	1/01AUG 89	1S-249/16 AUG 90 1S-250/09 OCT 90 1S-251/12 NOV 90 1S-252/29 JAN 91 1S-253/14 MAR 91
1C-141A-1-1/26 MAR 82	1/07 DEC 83	

BASIC/DATE	LAST CHG/DATE	SUP/DATE
1C-141A-5/30 AUG 68	11/27 OCT 80	5S-5/01 AUG 80
		5S-6/19 JUN 81
		5S-7/12 JUN 81
		5S-8/13 AUG 81
		5S-9/15 MAY 85
		5S-10/10 SEP 87
1C-141A-9/31 MAY 68	16/24 OCT 83	9S-56/03 MAR 89

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IMC 90-1	31 May 90
ASD Sup-1	29 Mar 91
Write-In Chg	05 Jun 91

VOLUME IX

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ASD Sup-1	24 Aug 90

VOLUME X

Basic	30 Jun 87
ASD Sup-1	21 Mar 88

VOLUME XII

Basic	12 Jun 87
Change 1	06 Sep 89
ASD Sup-1	01 Oct 87

VOLUME XIV

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IMC 88-2	08 Dec 88
IMC 90-1	05 Dec 90
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Change 1 20 Feb 90
Change 2 09 Nov 90

AFM 51-9 07 Sep 90

AFM 51-40 15 Mar 83
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Change 2 02 Jan 89

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Change 1 15 Feb 91

AFR 60-1 09 Feb 90
Change 1 20 May 91
AFSC Sup-1 05 Oct 90
IMC 91-1 26 Mar 91
ASD Sup-1 15 Jul 91

AFSCR 60-1 13 Apr 82
Change 1 28 Mar 83
Change 2 19 Mar 85
IMC 86-1 20 Feb 86
IMC 89-1 24 Jan 89
IMC 89-2 01 Nov 89
IMC 89-3 11 Jan 90
IMC 91-1 30 APR 91
4950TW Sup-1 01 Jul 86
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Change 1	16 Nov 89
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Change 1	21 Aug 89
ASD Sup-1	26 Jul 88

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Change 3 02 Jul 91

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Change 1 19 Dec 89
AFSC Sup-1 08 Dec 89
IMC 90-1 21 Jun 90
ASD Sup-1 06 Apr 90
4950TW Sup-1 09 Apr 90

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TWR 71-1 27 Aug 90

MASTER QUESTIONAIRE FILE

ACFT/POSITION	BASIC	CHANGES
C-18		
Pilot	31 May 89	
Nav	01 May 89	
F.E.	23 May 89	
T-37		
Pilot	01 Aug 88	
T-39		
Pilot	15 Aug 84	Chg 1, 26 Sep 84 Chg 2, 12 Jul 85 Chg 3, 23 Jan 87
C-135		
Pilot	01 Aug 88	Chg 1, 01 May 89
Nav	15 Jul 84	
F.E.	15 Jun 84	Chg 1, 01 Oct 85 Chg 2, 13 Apr 88 Chg 3, 20 Jul 88
F.S.	01 May 84	
EWO	15 Sep 84	Chg 1, 08 Oct 85
C-141		
Pilot	06 Apr 90	Chg 1, 12 Oct 90
Nav	15 Jul 88	
F.E.	05 Feb 90	Chg 1, 06 Apr 90 Chg 2, 31 Jul 91
L.M.	09 Feb 90	

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Vita

Major Charles P. Modrich was born on 16 November 1955 in Mount Clemens Michigan. He graduated from Carl Brablec High School in Roseville, Michigan in 1973 and attended the University of Colorado, graduating with a Bachelor of Science in Electrical Engineering in December of 1977. Upon graduation he received a reserve commission in the USAF and served his first assignment at Columbus AFB, Mississippi, where he attended Undergraduate Pilot Training (UPT). After graduating from UPT he was assigned to Wurtsmith AFB, Michigan where he flew the KC-135A aircraft for the next five years. Following this tour in Strategic Air Command Major Modrich was assigned to Air Force Systems Command in the 4950th Test Wing, Wright-Patterson AFB, Ohio. Here he served for six years in a variety of roles, including research pilot, program manager, and AFSC chief C-18 flight examiner. In May 1990, Major Modrich entered the School of Systems and Logistics, Air Force Institute of Technology.

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12a. DISTRIBUTION/AVAILABILITY STATEMENT
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13. ABSTRACT *(Maximum 200 words)*
The original intent of this research was to locate or develop tools which would improve the efficiency of the aircrew scheduling process in the 4950th Test Wing. However, late in the research it became apparent that several factors observed by the researcher complicate the implementation of more efficient methods. Therefore, the focus of the research became the documentation of those factors. A case study methodology was used in answering the investigative questions. This was an exploratory study conducted in a field setting environment. Direct observation and the use of structural interviews with scheduling personnel were the methods of data collection. An exhaustive search revealed numerous aircrew scheduling support systems in use within the USAF today. Many others were found under a development and test status. However, it was found that no measure of scheduling efficiency was currently in use in the subject unit. In addition, there was no attempt to use surrogate parameters to measure how well the schedulers were performing their jobs. Recommendations on what parameters may serve as good surrogates for scheduling efficiency are suggested. These parameters may serve as baseline efficiency measures which can serve to assess the success of future improvement efforts.

14. SUBJECT TERMS
Scheduling, Operational Effectiveness, Flight Crews, Operators (Personnel).

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4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

   a. Highly Significant   b. Significant   c. Slightly Significant   d. Of No Significance

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